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THE

ONTARIO WATER RESOURCES

COMMISSION

RECORDING

INSTRUMENT SUPPORT STRUCTURE

1969

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Recording instrument support  
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RECORDING INSTRUMENT SUPPORT STRUCTURE

1969

135 St. Clair Avenue West  
Toronto 195, Ontario

M.D. Palmer,  
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## RECORDING INSTRUMENT SUPPORT STRUCTURE

### ABSTRACT

A support structure for water depths up to 10.9m (35 feet) was designed and tested. The structure is of modular design and thus can be transported by a small commercial truck. After assembly onshore it is lowered onto the water with a crane, and towed to the installation site using a small boat, where it is lowered into position without the assistance of a floating crane or divers. The structure provides an above surface platform for meteorological equipment and navigation light as well as the capability of raising and lowering sub-surface equipment without the assistance of divers. The structure was removed and installed in a new location 13km (8.0 miles) away in seven hours with a 9.1m (30 foot) boat while ideal weather conditions prevailed.

## RECORDING INSTRUMENT SUPPORT STRUCTURE

### INTRODUCTION

During the past few years, the Ontario Water Resources Commission has operated submersible recording current meters, and more recently, water quality sensing systems in the near shore areas of the Great Lakes as part of its environmental study programs. Appropriate support systems were consequently developed for these instruments. The support system development has been evolutionary leading to progressive improvements from the operational and economical point-of-view. A description of two of the earlier support systems employed and their limitations is provided as background to the eventual development of the monopod system.

A submerged buoy system, designed primarily for waters deeper than 12.2m (40 feet) was installed in 12.8m (42 feet) of water, and 1.6km (1 mile) offshore. To obtain the greatest possible separation for the installation of two current meters it was necessary to locate the buoy as close to the surface as possible, but far enough below the surface to prevent system failure by wave action. The nearest wave records were at Port Credit, 40 km (25 miles) to the west. These were developed by standard wind casting techniques. The 10 year design wave thus arrived at is 1.83m (6 feet) (Baines 1962).

It was decided that a safe submergence for the buoy system would be 2.45 to 3.05m (8 to 10 feet). The submerged buoy was subsequently installed 2.45m (9 feet) below the water surface. The anchor blocks shifted during the first month of operation and thus permitted the buoy to come within a few feet of the surface resulting in failure due to wave action. The system was re-established using the new anchor block locations and operated satisfactorily for three months, when a further failure occurred due to wave forces. While the system was designed to withstand some movement of the submerged buoys, it appears that waves of the order of the estimated 10 year design wave occurred frequently enough to wear through a 4.77m (3/16 inch) stainless steel cable rubbing on aluminium and cause a break in the cable supporting the meters as well as puncturing the aluminium buoy at the wear points. A submerged buoy support system requires a large submergence to escape significant wave forces thus restricting the attached meters to depths well below the surface. This system furthermore requires a floating crane for the positioning of anchor blocks as well as divers for both the installation and subsequent maintenance of the meters. It does not have facilities for the installation of recording meteorological

equipment, thus necessitating an additional surface buoy for this purpose. These limitations as they apply to shallow waters lead to the design and use of a second system.

The second system employed was a tower constructed of standard heavy duty television tower sections. The details of this system are described in the report "Currents in the Nanticoke Region of Lake Erie, 1968". Two variations of this system were employed. One consisted of a standard tower 12.2m (40 feet) high sitting on a base and guyed to concrete anchor blocks with steel cables. The second tower was a 3.05 or 6.10m (10 or 20 feet) high attached and guyed to a heavy pad. Both proved very satisfactory, particularly the submerged towers which could be fabricated onshore. Both towers however required divers for installation and maintenance on the meters. Furthermore the installation required a large vessel with a crane or boom such as a boat crane or fishing vessel.

The Commission consequently decided to design and fabricate a support system which would meet the following specifications:

1. The structure shall be capable of operating in depths of up to 10.7m (35 feet) and be complete with facilities for the mounting of recording meteorological equipment;



2. It shall be transportable by a small standard commercial truck;
3. The design shall permit installation and relocation of the system by a small boat without crane or diver assistance;
4. Facilities shall be provided for the lowering and raising of meters without diver assistance;
5. Provision shall be made for the location of meters at any desired depth.

A system designated a Monopod, was designed to meet these requirements.

#### SUPPORT SYSTEM

##### General

The requirements dictated the following design concepts:

1. It must have a buoyant state if no floating crane is to be used;
2. It must disassemble into sections not in excess of 6.1m (20 feet) and have a total weight of less than 1.81 tons metric (2 short tons);
3. It must be capable of withstanding large wave forces and currents; consequently, the cross sectional area at the air-water interface should be minimized.

After examining various system configurations, the one portrayed in Figure 1 and photographs (page 12) was selected. This configuration minimized the forces on the structure due to currents, waves and winds by keeping the bulk of the structure

near the bottom while providing an above surface platform for meteorological equipment and a navigational light. It has a base consisting of three steel pressure tanks fixed at the vertices of an equilateral triangle by standard steel roof trusses. An aluminium pipe mast 12.8m (42 feet) long was attached to the trusses and supported by three stainless steel wire guys extending from the steel pressure tanks. The tanks were sized to provide the required buoyancy for stability under tow and to permit controllable air release on sinking. The equilateral triangular base dimensions and the weight of the tanks were selected to provide the required resistance to overturning moments from wave forces, currents, and small boat collisions.

#### Base

Experience on the Great Lakes has indicated that fixed structures require anchors of approximately 453k (1000 lbs). Individual tanks each weighing approximately 453k (1000 lbs) located at the vertices of a triangle with 9.75m (32 feet) sides were selected. At a depth of 10.7m (35 feet), it is capable of resisting a horizontal force at the water surface of 181k (400 lbs) based on the dead weight and rigid connections. Tanks and trusses were fabricated in steel to provide the

necessary dead weight and reduce costs. The shape of the tanks was selected on the basis of ease of fabrication and the ability to lift free of the bottom when the structure is floated. The horizontal forces due to waves (1.83m), currents (0.515m/sec) (Hamblin, 1967) and winds (25m/sec) (Schlichting, 1955 and Weigel, 1964) on a 11.4cm (4.5 in) diameter pipe in 10.7m (35 feet) of water and three tanks and trusses are approximately 36.2k (80 lbs). An additional force of 136k (300 lbs) to resist a boat collision which is likely to occur in the near shore areas is thus available.

#### Mast

An aluminium mast with a 10.16cm (4 in) diameter nominal pipe was required to house the air hoses extending from the surface to the tanks. A pipe wall thickness schedule 40 was selected to meet strength requirements for the support of two men and associated instrumentation as a column supported by guys located just below the surface. This location of guys on the mast has been found desirable to protect curious small boaters who may bring their boats near the structure. Aluminium was selected to minimize the weight above the base and eliminate any interaction between the meter compasses and the structure. The instruments were attached to steel cables

running over pulley wheels at the top and bottom of the mast (similar to a vertical clothesline). Three instrument support cables were provided. It was thus possible to raise and lower the meters to any desired depth from the surface without diver assistance.

#### Air System

The air system controlling the buoyancy of the tanks consisted of 1.59cm (5/8 inch) outside diameter rubber hose to each tank branching from a manifold at the base of the mast. Gate valves are provided at each tank to assist in the installation and recovery if failure occurs. Another 1.59cm (5/8 inch) diameter hose extends from the manifold up the centre of the mast to the top. It was thus possible to control air movements through the hose when the structure was either floating or submerged.

A secondary air system, called the high pressure system, similar to the above system was passed through the tanks to a radial distribution manifold at the bottom of each tank. High pressure air could thus be forced under each tank to assist in demudding or suction breaking. The water inlets for the tanks were similarly located above the bottom of the tanks to prevent mudding.

### Above Surface Platform

A small aluminium platform, 0.65m (2 feet) below the top of mast, was provided as a working platform for the servicing of the navigation light, recording anemometer and assorted power supplies. A large open box with drain holes was provided for battery storage and a temporary safe storage area for tools and equipment while working on the instruments. The platform was located about 2.44m (9 feet) above water to protect it from tampering. The platform was reached by employing a specially designed 1.5m (5 foot) aluminium ladder which hooked into holes on the platform. The ladder is small enough to be easily handled from a 4.25m (14 foot) boat.

### INSTALLATION

To prevent upsetting of the structure during the installation or removal of the structure, it is necessary to attach a float to the mast near the submerged water level. Once the structure is assembled at the waters edge, a crane or boom truck may be used to place it in water deeper than one meter (3 feet). The structure can now be towed with a line attached to one of the tanks. It is very stable under tow, however, maximum tow speeds should be restricted to approximately 7.4kph (4 knots).

After positioning the structure at the desired location, the air is bled off from each tank independantly until the tanks are practically submerged. The remaining air is then released from all tanks simultaneously. Although the structure is likely to sink at an angle, the float on the mast and the location of the air release points on the tanks will ensure that the structure will sit properly on the bottom once all the air is released. If the vertical alignment of the mast is not acceptable, the structure can be refloated. When the structure is refloated using compressed gas from cylinders two tanks generally come to the surface first. In this case it is necessary to give the structure a tow with the boat to set it upright.

#### FIELD TESTS

The structure was unloaded from a truck, assembled and placed in the water by four men and a crane in five hours. In the first installation in 10.7m (35 feet) of water the mast was at an angle of  $5^{\circ}$  or  $6^{\circ}$  to the vertical indicating a bottom elevation difference of 0.36m (14 inches) at the base. Although at this slant the structure withstood seas resulting from winds in excess of 74kph (40 knots) with a long fetch. In calmer weather it supported two men on the top platform. After resting on a silt bottom for two weeks, the structure was removed

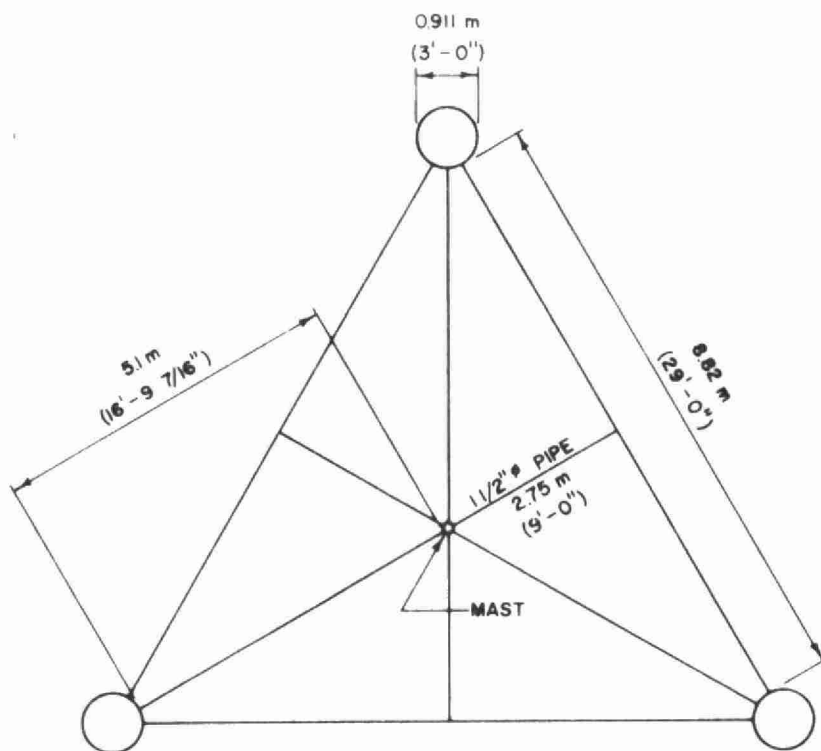
without difficulty utilising the demudding air system.

As the initial step of a transfer operation the attached instruments were removed at 10 AM. The structure was then raised, towed 13km (9 miles) and installed in 10.7m (35 feet) of water. A recording meter was then attached and placed in operation by 5:15 PM. This work was carried out by a 9.1m (30 feet) boat and a crew of three. Divers or floating cranes were not required.

Long term field trials are presently underway to assess susceptibility to corrosion and weed growths.

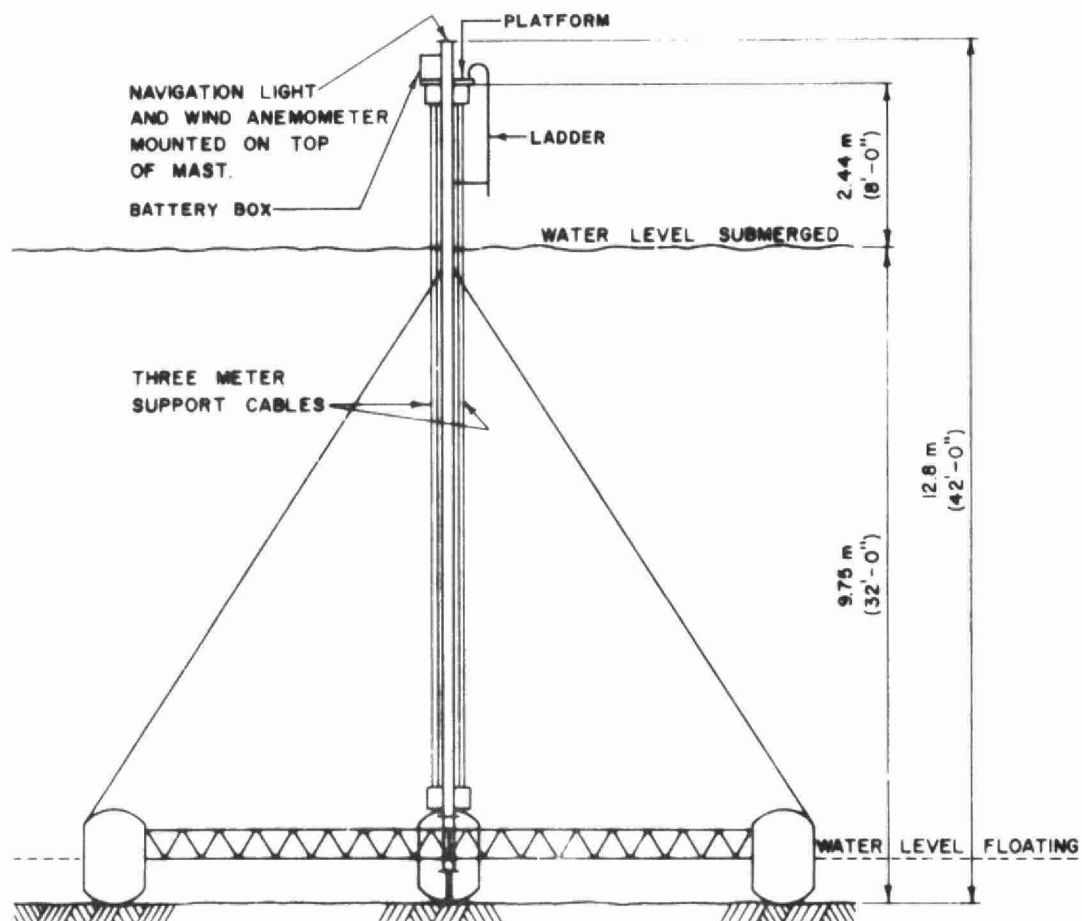
#### CONCLUSIONS

The monopod structure has met all the design specifications. It provides a highly mobile platform for use in near-shore water and is simple to relocate.



PLAN OF MONOPOD SYSTEM

NOT TO SCALE



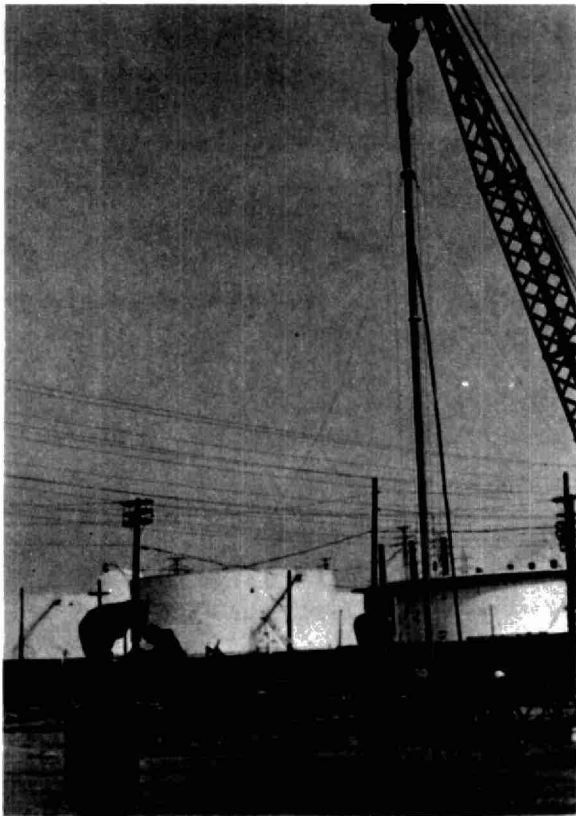
ELEVATION

NOT TO SCALE

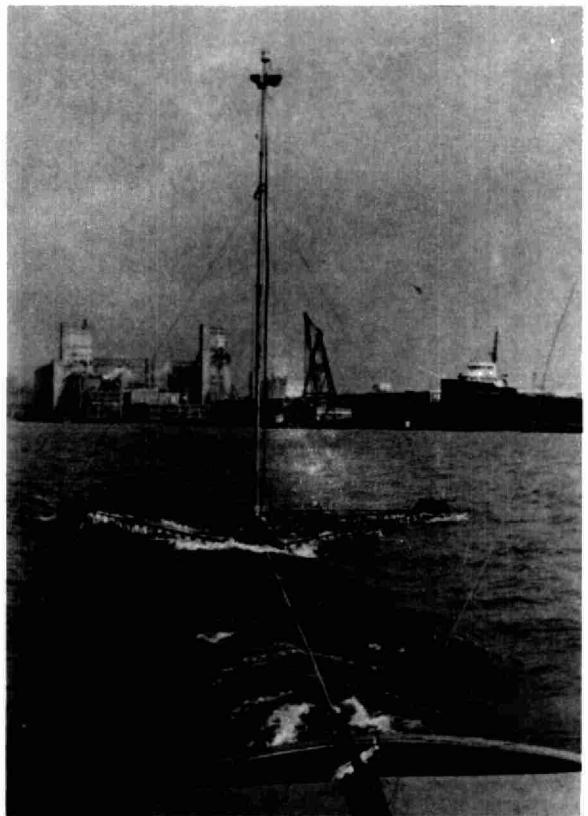
FIGURE N° 1

DESIGNED BY M.D. PALMER  
OW RC — MAY, 1969 — 69-59-GL

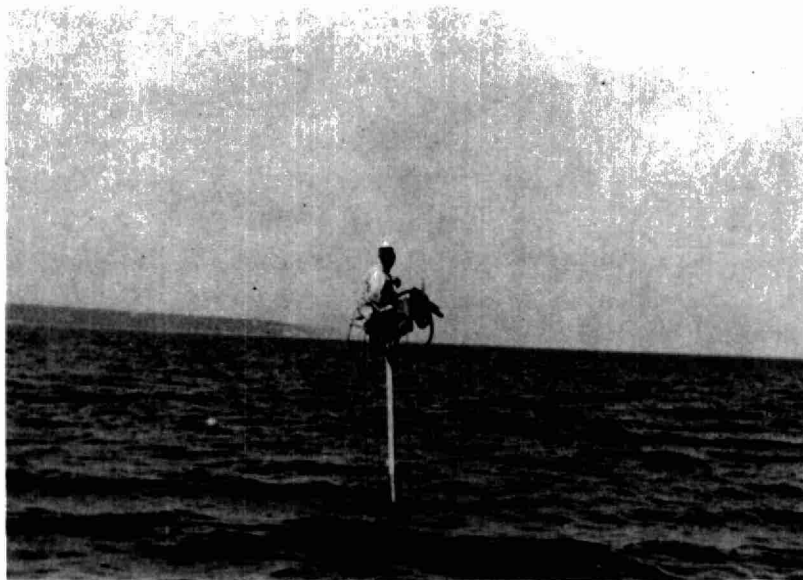




Assembly on shore with crane



Under Tow



Installed

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